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## REMARKS

By this amendment, claims 1-5, 10-14, 16-25, 34-35, 38, 51-56 and 58-94 are pending in the application. Of these, claims 1, 2, 10, 12, 14, 16-18, 20-22, 24, 34, 35, 51, 52, 55, 56, 58, 62, 64-68 and 70 are being amended, and claims 71-82 are being added. Claims 6-9, 15, 36-37 and 57 are being canceled. Claims 26-33 and 39-50 remain withdrawn.

The claim amendments and added claims are fully supported by the original claims and specification, and entry of the claim amendments and added claims is respectfully requested. For example, the amendment to claim 1 to recite "changing the first composition of the etching gas to a second composition to etch the mask material," is supported at least by the paragraph starting on page 15, line 4 of the Specification. The recitation of "a non-polymer forming gas," as in claim 34, is supported by the same paragraph, which describes "introducing a non-polymerizing mask etching gas." Also, newly added claim 74 which recites "changing the first gas composition to the second gas composition without stopping a flow of the non-polymer forming gas" is supported at least by Table 1 on page 18 of the Specification. This table shows first and second mask etch steps in which a non-polymer forming gas, namely  $\text{CF}_4$ , is provided in both first and second mask material etch steps, and thus is provided without stopping a flow of the gas after the first step.

The specification is also being amended in the paragraph starting on page 15, line 4 to further clarify the specification and ensure correspondence with the claims by reciting a "composition" of gas. The amendment is supported at least by the paragraph on page 10 of the Specification which recites at lines 8-9 of that page that "etchant gas compositions may be sequentially introduced into the chamber." Reconsideration of the present case in view of the amendments and remarks herein is respectfully requested.

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Objected to Claims 57 and 58.

Applicants appreciate the Examiner's indication that dependent claims 57 and 58 would be allowable if re-written in independent form including all of the limitations of their base claim and any intervening claims. The limitations of objected to claim 57 are being incorporated into claim 56, and thus claim 56 is believed to be allowable. Objected to claim 58 is being re-written in independent form as newly added claim 71, and this claim is believed to be allowable. However, as claim 71 does not include all of the limitations of intervening claim 57, Applicants respectfully request that the Examiner review claim 71 de novo.

Rejection Under 35 U.S.C. 102 of Claims 1-3, 6-25, 34-38, 51-56 and 59-70

The Examiner rejected claims 1-3, 6-25, 34-38, 51-56 and 59-70 under 35 U.S.C. 102(e) as being anticipated by U.S. Patent No. 6,037,266 to Tao et al. This rejection is traversed.

Claim 1 is not anticipated by Tao et al. because Tao et al. does not teach "(b) providing an energized etching gas in the process zone to etch the mask material, the energized etching gas comprising a first composition; [and] (c) changing the first composition of the etching gas to a second composition to etch the mask material," as recited in the claim. Tao et al. discloses a hard mask open etch with either C<sub>2</sub>F<sub>6</sub> or CF<sub>4</sub> (Column 3, Table, Step 2), and thus Tao et al. discloses providing a single gas composition, either C<sub>2</sub>F<sub>6</sub> or CF<sub>4</sub>, to etch the hard mask. Tao et al. does not teach etching mask material with a gas comprising a first composition, and then changing the gas composition to a second composition to etch the mask material, as in the claim. Accordingly, as Tao et al. does not teach the first and second compositions to etch the mask material, claim 1 and the claims depending therefrom are not anticipated by Tao et al.

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Similarly, claim 14 recites "(b) providing a first energized etching gas in the process zone to etch the mask material; [and] (c) after (b), providing a second energized etching gas in the process zone to etch the mask material." As discussed above, Tao et al. discloses providing a single gas composition to etch hard mask, namely either  $C_2F_6$  or  $CF_4$ , and thus Tao et al. does not teach or suggest providing a second gas after a first gas has been provided to etch mask material. Accordingly, claim 14 and the claims depending therefrom are not anticipated by Tao et al.

Claim 51 similarly recites " (b) providing an energized first process gas in the process zone to etch apertures in the mask material; [and] (c) after (b), providing an energized second process gas in the process zone to etch the apertures in the mask material," and thus claim 51 and the claims depending therefrom are not anticipated by Tao et al. because Tao et al. does not teach providing first and second gases to etch a mask material.

Claim 34 is not anticipated by Tao et al. because Tao et al. does not teach "providing a first energized process gas in the chamber to etch the mask material, the process gas comprising a polymer forming gas, thereby depositing process residue on surfaces of the process chamber; ... [and] providing a second energized process gas in the chamber comprising a non-polymer forming gas to simultaneously etch the mask material and at least partially remove the process residue from the surfaces of the process chamber," as recited in the claim. As discussed above, Tao et al. discloses providing a single gas composition of either  $C_2F_6$  or  $CF_4$  to etch hard mask. Thus, Tao et al. does not teach or suggest providing a first gas that deposits process residues and a second gas that cleans the process residues while etching the mask material. Accordingly, claim 34 and the claims depending therefrom are not anticipated by Tao et al.

Claim 55 is not anticipated by Tao et al. because Tao et al. does not teach "providing a substrate in a process zone, the substrate comprising ... an anti-reflective coating material that is between the first and second etch resistant materials, and a silicon-containing layer that is under the first and second etch resistant materials; [and]

providing a second energized process gas in the process zone to simultaneously remove the anti-reflective coating material and etch the silicon-containing layer, the second energized process gas comprising one or more of  $\text{CF}_4$ ,  $\text{C}_2\text{F}_6$ ,  $\text{NF}_3$ ,  $\text{SF}_6$ ,  $\text{Cl}_2$ ,  $\text{Br}_2$ ,  $\text{HBr}$ , and  $\text{HCl}$ ," as recited in the claim. Tao et al. discloses a BARC (bottom anti-reflective coating) stripping step (Column 3, Table, Step 3) that is performed before a polysilicon main etch step (Column 3, Table, Step 4), and thus discloses BARC stripping in a separate step before etching an underlying material. Tao et al. does not teach or suggest providing a gas that simultaneously removes and anti-reflective coating material and etches an underlying silicon-containing layer, as in the claim. Accordingly, Tao et al. does not teach each and every aspect of the claim, and claim 55 and the claims depending therefrom are not anticipated by Tao et al.

Claim 56 has been amended to incorporate the limitations of objected to claim 57, and thus claim 56 and the claims depending therefrom are believed to be allowable.

Claim 65 is not anticipated by Tao et al. because Tao et al. does not teach "(b) providing an energized mask etching gas in the process zone to etch the mask material, the mask etching gas having a first composition comprising a non-polymer forming gas; [and] (c) after (b), changing the first composition of the mask etching gas to a second composition comprising a polymer forming gas to etch the mask material," as recited in the claim. Instead, as discussed above, Tao et al. discloses providing a single composition of gas to etch hard mask, but does not teach providing a first etching gas comprising a non-polymer forming gas followed by a second etching gas comprising a polymer-forming gas. Accordingly, claim 65 and the claims depending therefrom are not anticipated by Tao et al.

Claim 70 is not anticipated by Tao et al. because Tao et al. does not teach "providing a substrate in a process zone, the substrate comprising ... an anti-reflective coating material that is between the resist material and mask material; (b) providing an energized first mask etching gas in the process zone to etch apertures in the mask

material, the energized first mask etching gas comprising one or more of  $\text{CF}_4$ ,  $\text{C}_2\text{F}_6$ ,  $\text{NF}_3$  and  $\text{SF}_6$ ; (c) after (b), providing an energized second mask etching gas in the process zone to etch the apertures, the energized second mask etching gas comprising one or more of  $\text{CHF}_3$ ,  $\text{CH}_2\text{F}_2$ , and  $\text{CH}_3\text{F}$ ; ... [and] providing an energized process gas in the process zone to simultaneously remove the anti-reflective coating material and etch the silicon-containing material, the process gas comprising one or more of  $\text{CF}_4$ ,  $\text{C}_2\text{F}_6$ ,  $\text{NF}_3$ ,  $\text{SF}_6$ ,  $\text{Cl}_2$ ,  $\text{Br}_2$ ,  $\text{HBR}$ , and  $\text{HCl}$ ," as recited in the claim. Instead, as discussed above, Tao et al. discloses providing a single composition of gas to etch hard mask, but does not teach providing a first gas comprising one or more of  $\text{CF}_4$ ,  $\text{C}_2\text{F}_6$ ,  $\text{NF}_3$  and  $\text{SF}_6$  followed by a second gas comprising one or more of  $\text{CHF}_3$ ,  $\text{CH}_2\text{F}_2$ , and  $\text{CH}_3\text{F}$ , as in the claim. Also, Tao et al. discloses removing a BARC layer in a separate step, but does not teach simultaneously removing anti-reflective coating material with a silicon-containing material, as in the claim. Accordingly, claim 70 and the claims depending therefrom are not anticipated by Tao et al.

The Examiner rejected claims 1-3, 6-25, 34-38, 51-56 and 59-70 under 35 U.S.C. 102(b) as being anticipated by U.S. Patent No. 5,346,586 to Keller et al. This rejection is traversed.

Claim 1 is not anticipated by Keller et al. because Keller et al. does not teach "providing an energized etching gas in the process zone to etch the mask material, the energized etching gas comprising a first composition; [and] (c) changing the first composition of the etching gas to a second composition to etch the mask material," as recited in the claim. Keller et al. discloses that "oxide layer 20 is etched through the photoresist mask to form an oxide hard mask 24. A suitable etchant gas chemistry for etching the oxide layer 20 includes  $\text{CF}_4$  and  $\text{CHF}_3$  gases." (Column 4, lines 62-66.) Thus, Keller et al. discloses providing a single gas composition, such as a composition comprising  $\text{CF}_4$  and  $\text{CHF}_3$ , but does not teach or suggest providing an etching gas comprising a first composition, and changing the first composition to a second composition to etch the mask material, as in the claim. Accordingly, claim 1 and the claims depending therefrom are not anticipated by Keller et al.

Claim 14 similarly recites "(b) providing a first energized etching gas in the process zone to etch the mask material; [and] (c) after (b), providing a second energized etching gas in the process zone to etch the mask material," and thus this claim and the claims depending therefrom are not anticipated by Keller et al. because Keller discloses providing a single gas composition, such as  $\text{CF}_4$  and  $\text{CHF}_3$ , but does not teach providing a first etching gas followed by a second etching gas to etch mask material, as in the claim.

Claim 51 similarly recites "(b) providing an energized first process gas in the process zone to etch apertures in the mask material; and (c) after (b), providing an energized second process gas in the process zone to etch the apertures in the mask material." Thus, claim 51 and the claims depending therefrom are not anticipated by Keller et al. because Keller et al. does not teach providing first and second energized gases, as in the claim.

Claim 34 is not anticipated by Keller et al. because Keller et al. does not teach "providing a first energized process gas in the chamber to etch the mask material, the process gas comprising a polymer forming gas, thereby depositing process residue on surfaces of the process chamber; ... [and] providing a second energized process gas in the chamber comprising a non-polymer forming gas to simultaneously etch the mask material and at least partially remove the process residue from the surfaces of the process chamber," as recited in the claim. As discussed above, Keller et al. discloses providing a single composition of gas, such as  $\text{CF}_4$  and  $\text{CHF}_3$  to etch hard mask. Thus, Keller et al. does not teach etching mask material by providing first energized process gas that deposits residue on surfaces in the chamber, and a second energized process gas that simultaneously cleans the residue and etches the mask material. Accordingly, claim 34 and the claims depending therefrom are not anticipated by Keller et al.

Claim 55 is not anticipated by Keller et al. because Keller et al. does not teach or suggest "providing a substrate in a process zone, the substrate comprising ...

an anti-reflective coating material that is between the first and second etch resistant materials ... [and] providing a second energized process gas in the process zone to simultaneously remove the anti-reflective coating material and etch the silicon-containing layer, the second energized process gas comprising one or more of  $\text{CF}_4$ ,  $\text{C}_2\text{F}_6$ ,  $\text{NF}_3$ ,  $\text{SF}_6$ ,  $\text{Cl}_2$ ,  $\text{Br}_2$ ,  $\text{HBr}$ , and  $\text{HCl}$ ," as recited in the claim. Keller et al. does not teach a substrate comprising an anti-reflective coating material, and thus also does not teach removing such a material from a substrate. Accordingly, claim 55 is not anticipated by Keller et al.

Claim 56 has been amended to incorporate the limitations of objected to claim 57, and thus this claim and the claims depending therefrom are believed to be allowable.

Claim 65 is not anticipated by Keller et al. because Keller et al. does not teach "(b) providing an energized mask etching gas in the process zone to etch the mask material, the mask etching gas having a first composition comprising a non-polymer forming gas; [and] (c) after (b), changing the first composition of the mask etching gas to a second composition comprising a polymer forming gas to etch the mask material," as recited in the claim. Instead, as discussed above, Keller et al. discloses providing a single composition to etch hard mask, such as a composition of  $\text{CF}_4$  and  $\text{CHF}_3$ , but does not teach providing a first gas composition and changing to a second gas composition to etch mask material, as in the claim. Accordingly, claim 65 and the claims depending therefrom are not anticipated by Keller et al.

Claim 70 is not anticipated by Keller et al. because Keller et al. does not teach "providing a substrate in a process zone, the substrate comprising ... an anti-reflective coating material that is between the resist material and mask material; (b) providing an energized first mask etching gas in the process zone to etch apertures in the mask material, the energized first mask etching gas comprising one or more of  $\text{CF}_4$ ,  $\text{C}_2\text{F}_6$ ,  $\text{NF}_3$  and  $\text{SF}_6$ ; (c) after (b), providing an energized second mask etching gas in the process zone to etch the apertures, the energized second mask etching gas comprising



one or more of  $\text{CHF}_3$ ,  $\text{CH}_2\text{F}_2$ , and  $\text{CH}_3\text{F}$ ; ... [and] providing an energized process gas in the process zone to simultaneously remove the anti-reflective coating material and etch the silicon-containing material, the process gas comprising one or more of  $\text{CF}_4$ ,  $\text{C}_2\text{F}_6$ ,  $\text{NF}_3$ ,  $\text{SF}_6$ ,  $\text{Cl}_2$ ,  $\text{Br}_2$ ,  $\text{HBR}$ , and  $\text{HCl}$ ," as recited in the claim. Instead, as discussed above, Keller et al. discloses providing a single gas composition, such as  $\text{CF}_4$  and  $\text{CHF}_3$ , to etch mask material, but does not teach providing a first energized gas followed by a second energized gas to etch mask material. Furthermore, Keller et al. does not teach removing anti-reflective coating material from a substrate. Accordingly, claim 70 and the claims depending therefrom are not anticipated by Keller et al.

Rejection Under 35 U.S.C. 103(a) of Claims 4-5.

The Examiner rejected claims 4 and 5 under 35 U.S.C. 103(a) as being unpatentable over either of Tao et al. and Keller et al. This rejection is traversed.

Claim 1, from which claims 4-5 depend, is patentable over Tao et al. because Tao et al. does not teach or suggest "(b) providing an energized etching gas in the process zone to etch the mask material, the energized etching gas comprising a first composition; [and] (c) changing the first composition of the etching gas to a second composition to etch the mask material," as recited in the claim. As discussed above, Tao et al. discloses providing a single gas composition, either  $\text{C}_2\text{F}_6$  or  $\text{CF}_4$ , and does not teach changing the composition to a second composition to etch mask material. Furthermore Tao et al. does not teach or suggest any benefits of changing the composition of the energized etching gas. For example, Tao et al. does not teach or suggest the benefits of providing process gas comprising a first composition having a non-polymer forming gas and changing to a second composition comprising a polymer forming gas. As described in the specification "By first introducing a non-polymerizing mask etching gas, the mask material 240 may be etched and the etchant residue may be cleaned from the chamber surfaces 275 before the polymeric residue is formed and deposited on the chamber surfaces 275. It is advantageous to use the mask material etchant gas comprising polymer forming gas because it aids in etch process



performance." (page 15, lines 20-24) Thus, in this example, a first composition that is non-polymer forming is provided so residue can be cleaned from the chamber, after which a second polymer forming composition is provided to aid the process performance. Tao et al. does not teach or suggest such benefits, and thus one of ordinary skill in the art would not find it obvious, based on the teachings of Tao et al, to provide first and second etching gas compositions to etch mask material. Accordingly, claim 1 and the claims depending therefrom are patentable over Tao et al.

Claim 1, from which claims 4-5 depend, is also patentable over Keller et al. because Keller et al. also does not teach providing first and second compositions to etch mask material. Instead, as discussed above, Keller et al. discloses providing a single gas composition comprising, for example,  $\text{CF}_4$  and  $\text{CHF}_3$ , but does not teach or suggest changing from a first composition to a second composition to etch mask material. Keller et al. also does not teach or suggest any advantages that could be obtained by changing from a first composition to a second composition. Accordingly, claim 1 and the claims depending therefrom are patentable over Keller et al. Furthermore, as neither Tao et al. or Keller et al. teach or suggest providing first and second compositions, claim 1 is also patentable over the combined disclosures of these references

#### Added Claims

Newly added claim 71 is substantially similar to claim 56 with the limitations of objected to claim 58 incorporated therein. The limitations of intervening claim 57 have not been incorporated into this claim. However, the claim is believed to be allowable because none of the cited references teaches or suggests "forming apertures in the mask material by: (i) in a first step, exposing the mask material to energized first process gas in the process zone, the energized first process gas comprising one or more of  $\text{CF}_4$ ,  $\text{C}_2\text{F}_6$ ,  $\text{NF}_3$ , and  $\text{SF}_6$ ; and (ii) in a second step, exposing the mask material to energized second process gas in the process zone, the energized second process gas comprising one or more of  $\text{CHF}_3$ ,  $\text{CH}_2\text{F}_2$ , and  $\text{CH}_3\text{F}$ ," as recited in

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the claim. As discussed above, neither Tao et al. or Keller et al. teach or suggest exposing mask material to first and second process gases in first and second steps, and instead only disclose providing a single gas in a single hard mask etching step. Accordingly, claim 71 is believed to be allowable over Tao et al. and Keller et al.

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### CONCLUSION

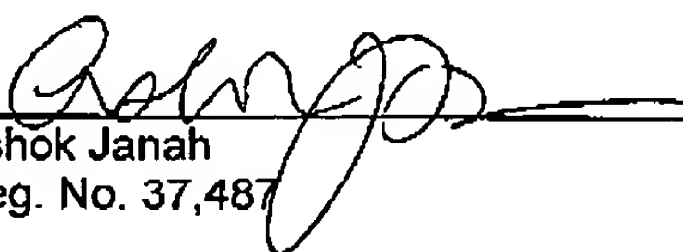
The above-discussed amendments are believed to place the present application in condition for allowance. Should the Examiner have any questions regarding the above remarks, the Examiner is requested to telephone Applicant's representative at the number listed below.

Respectfully submitted,

JANAH & ASSOCIATES  
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